An Overview of Monitoring Submerged Aquatic Vegetation in Coastal North Carolina

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Albemarle-Pamlico National Estuary Program

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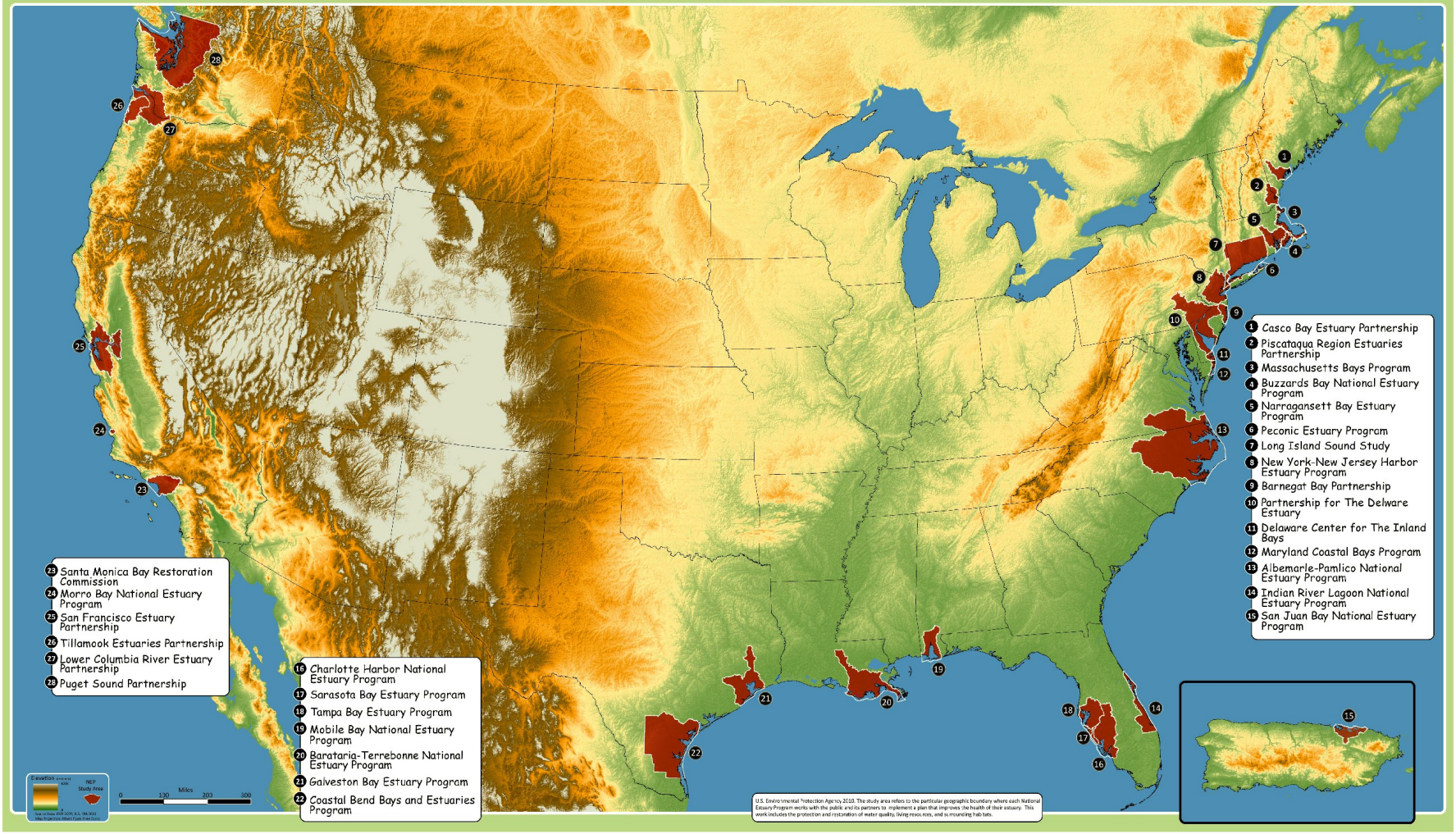
SAV Questions

- What is APNEP's role in natural resources conservation in general and SAV conservation in particular?
- How does SAV Partnership's monitoring and assessment activities address SAV resources?
- What are the particular technologies being developed and applied for SAV monitoring in coastal North Carolina?

NATIONAL ESTUARY PROGRAM STUDY AREAS


1 Casco Bay Estuary Partnership
2 Piscataqua Region Estuaries Partnership
3 Massachusetts Bays Program
4 Buzzards Bay National Estuary Program
5 Narragansett Bay Estuary Program
6 Peconic Estuary Program
7 Long Island Sound Study
8 New York-New Jersey Harbor Estuary Program
9 Barnegat Bay Partnership
10 Partnership for The Delware Estuary
11 Delaware Center for The Inland Bays
12 Maryland Coastal Bays Program
13 Albemarle-Pamlico National Estuary Program
14 Indian River Lagoon National Estuary Program
15 San Juan Bay National Estuary Program
16 Charlotte Harbor National Estuary Program
17 Sarasota Bay Estuary Program
18 Tampa Bay Estuary Program
19 Mobile Bay National Estuary Program
20 Barataria-Terrebonne National Estuary Program
21 Galveston Bay Estuary Program
22 Coastal Bend Bays and Estuaries Program
23 Santa Monica Bay Restoration Commission
24 Morro Bay National Estuary Program
25 San Francisco Estuary Partnership
26 Tillamook Estuaries Partnership
27 Lower Columbia River Estuary Partnership
28 Puget Sound Partnership
Miles
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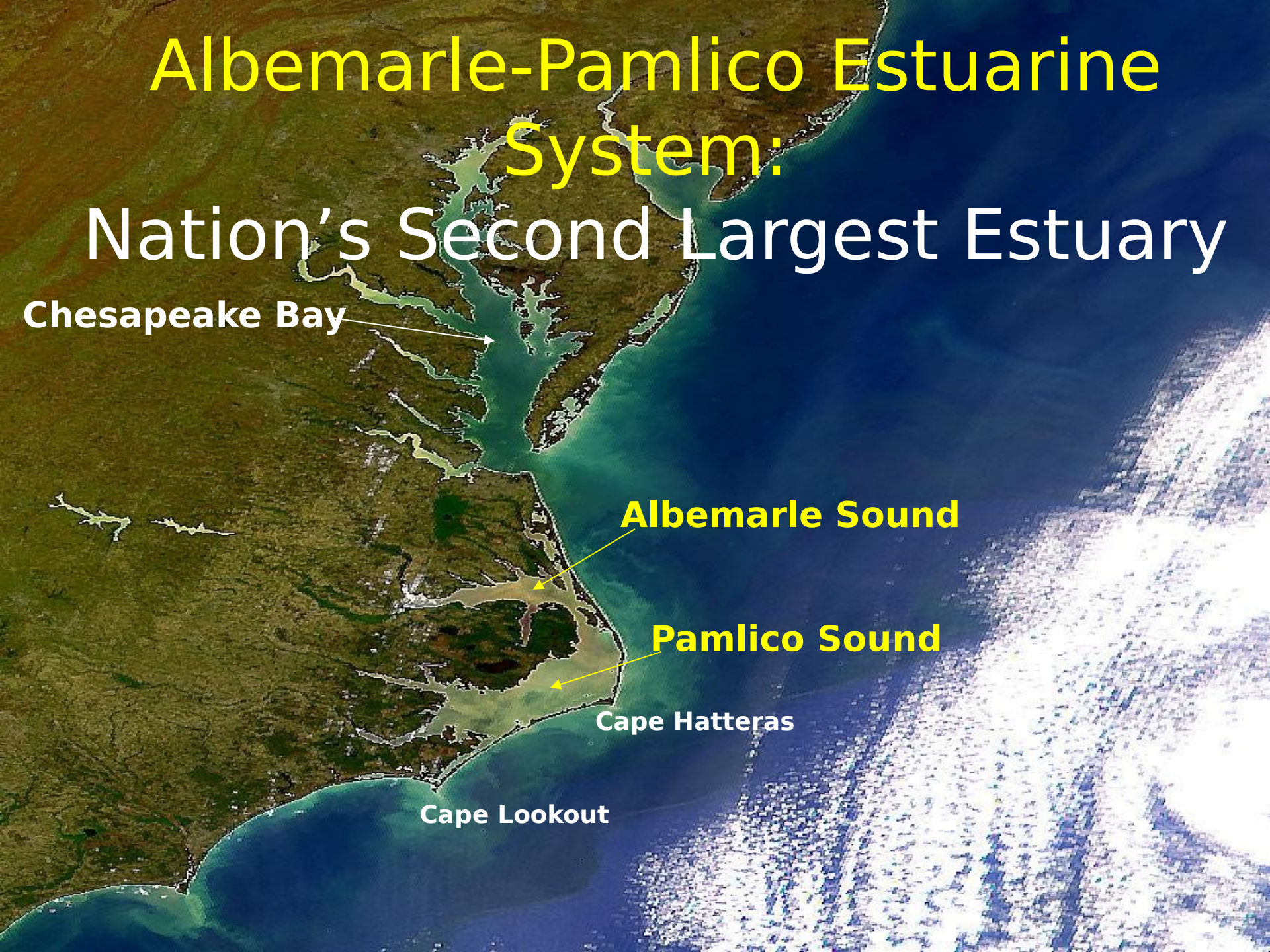
Albemarle-Pamlico Estuarine System:

Nation's Second Largest Estuary

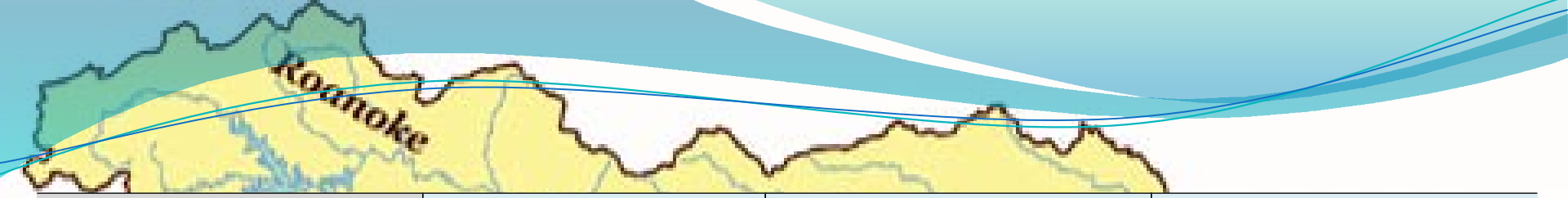


APNEP Mission

"To identify, restore, and protect the significant resources of the Albemarle-Pamlico estuarine system."

2012-2022 Comprehensive Conservation Management Plan

- CCMP Outcomes
  - **Ecosystem Outcome 2b**: The extent and quality of upland, freshwater, estuarine, and near-shore marine habitats fully support biodiversity and ecosystem function.
- CCMP Actions
  - **Protection Action B2.2:** Develop and implement a submerged aquatic vegetation (SAV) protection strategy. APNEP will work with its partners in protecting SAV habitats through mapping efforts, examination of permitting requirements, water quality and habitat issues, and education for boaters.
  - **Restoration Action C3.3: Develop and implement a submerged aquatic vegetation restoration strategy.** In conjunction with strategies to protect SAV (see B2.2), APNEP will work to restore areas capable of supporting SAV. This work will require study of effective restoration techniques, bathymetric mapping, water quality monitoring, and other efforts. APNEP will continue its contributions to the SAV Partnership to develop and promote a SAV restoration strategy.



2: Native Species	**2B: The extent and quality of upland, freshwater, estuarine and near-shore marine habitats fully support biodiversity and ecosystem function.**	**Estuarine/Marine Habitats (Stressors)**	**SAV Area/Zone/Density/Potential/Phenology by Species**
			Water Quality in SAV Habitats & Shellfish Waters
		Freshwater Habitats (Stressors)	Freshwater Hard Bottom
			Quality & Extent of Anadromous Fish Spawning/Nursery Areas
			Inaccessible Fish Spawning Area by Obstruction Type
		Wetland Habitats (Stressors)	Wetland Community Representation
			Hydrological Alteration in Wetlands
		Upland Habitat Index (Stressors)	Extent of Highly Eroded Soils
			Total Conservation Land
			Total Woodland Area; Area of Specific Forest Types
		Habitat Management	Permitted Wetland Losses
			Wetland Restoration
	2C: Non-native invasive species do not significantly impair native species' viability or function, nor impair habitat quality, quantity, and the processes that form and maintain habitats.	**Invasive Aquatic Plant Species**	Eurasian Watermillfoil Population Status/Occurrences
			Hydrilla Population Status/Occurrences
		Invasive Wetland Plant Species	Phragmites australis Population Status/Occurrences, Alligator Weed (Invasive Comm)
		Invasive Wetland Faunal Species	Nutria Population Estimates; Notable Local Populations
		Invasive Upland Plant Species	Privet Population Status/Occurrences
			Microstegium Population Status/Occurrences
			Kudzu Population Status/Occurrences
			Ailanthus altissima Status/Occurrences
			Paulownia tomentosa Status/Occurrences
		Invasive Upland Faunal Species	Feral Hog Population Estimates; Notable Local Populations
			Fire Ants Population Status/Occurrences

SAV Partnership

- Federal: ACE, FWS, NOAA, NPS, NRCS
- Mixed: APNEP, NERR
- State: DCM, DMF, DWQ, DWR, EEP, WRC, DOT
- Academia: ECSU, ECU, NCSU, UNC-CSI, UNC-IMS, UNC-W, NC Sea Grant, DUML, CW&M-VIMS
- NGOs: NCCF, TNC

The First Complete* Mapping of North Carolina's Submerged Aquatic Vegetation Resources

Don Field
NOAA – NOS – NCCOS
Center for Coastal Fisheries
and Habitat Research
Beaufort, NC

Monitoring and Mapping Objective

Monitor and map the distribution and abundance of Submerged Aquatic Vegetation (SAV) in North Carolina's and southeastern Virginia's estuarine and coastal waters. The network will cover the waters from Back Bay, VA, to the NC/SC

Environmental Parameters for Submerged Habitat Mapping

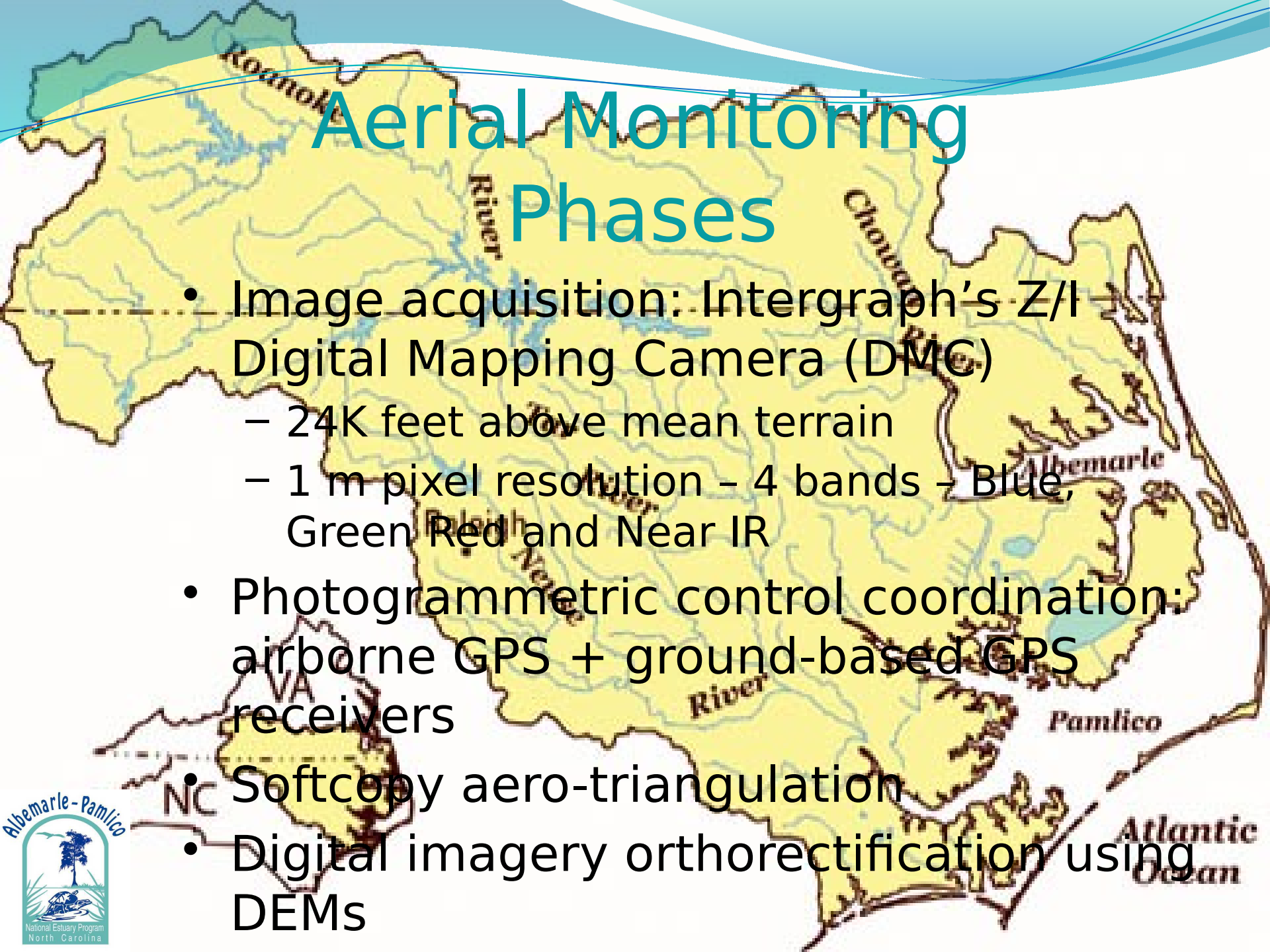
- Winds low – preferably 5 mph or less
- Sun Angle 20 – 45 degrees to reduce glint
- Low tide
- Turbidity low
- No clouds or haze
- Adequate biomass of target

2007 Monitoring Activities

- Resources: APNEP, FWS, DMF
  - NOAA IDIQ Contract Mechanism
- Flights: Aerometric, Dewberry
- Water Clarity Volunteer Network (Chappell-DMF)
  - 25 citizens: secchi depth
- Ground Truth Network

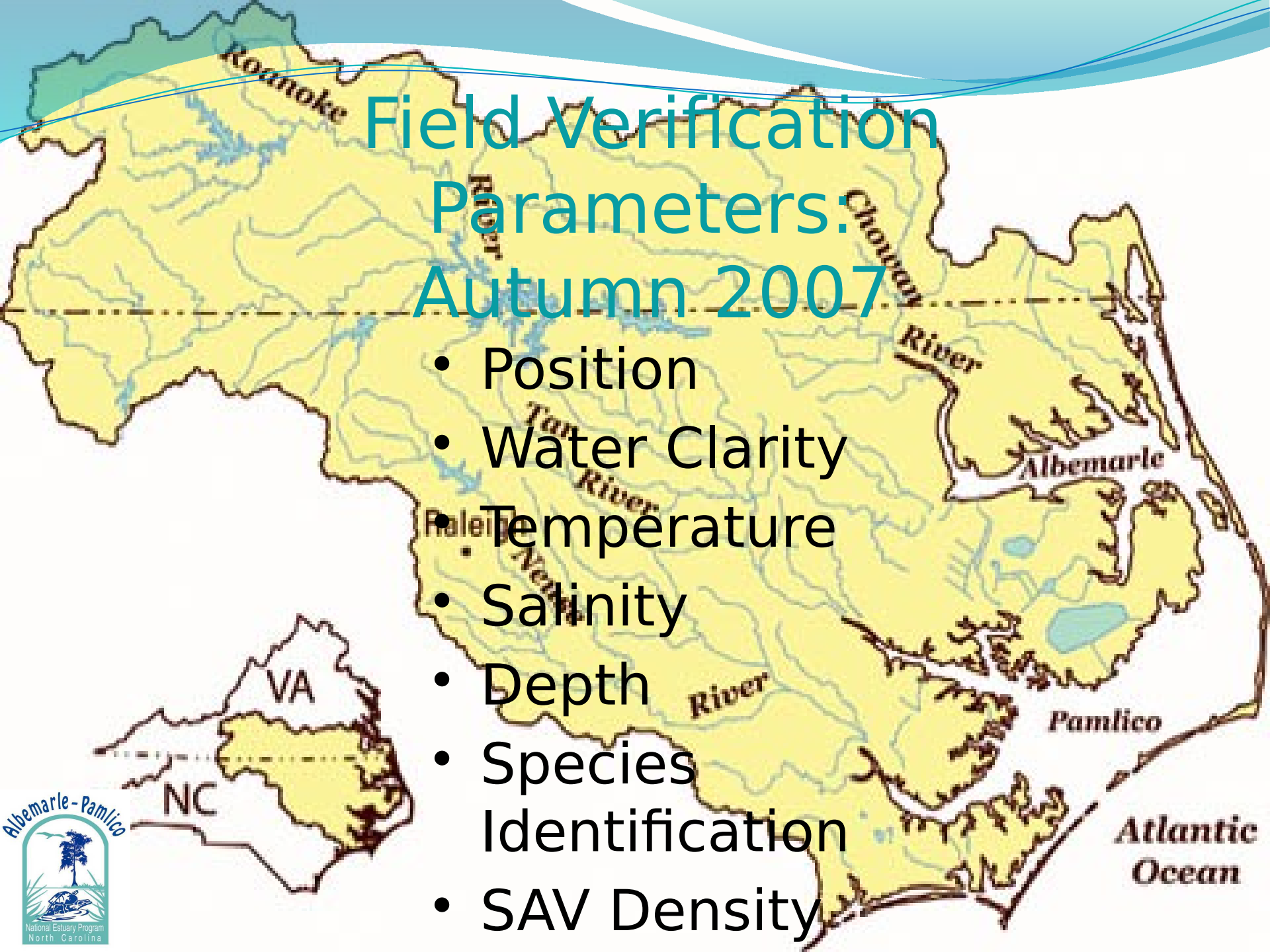
Aerial Monitoring Phases

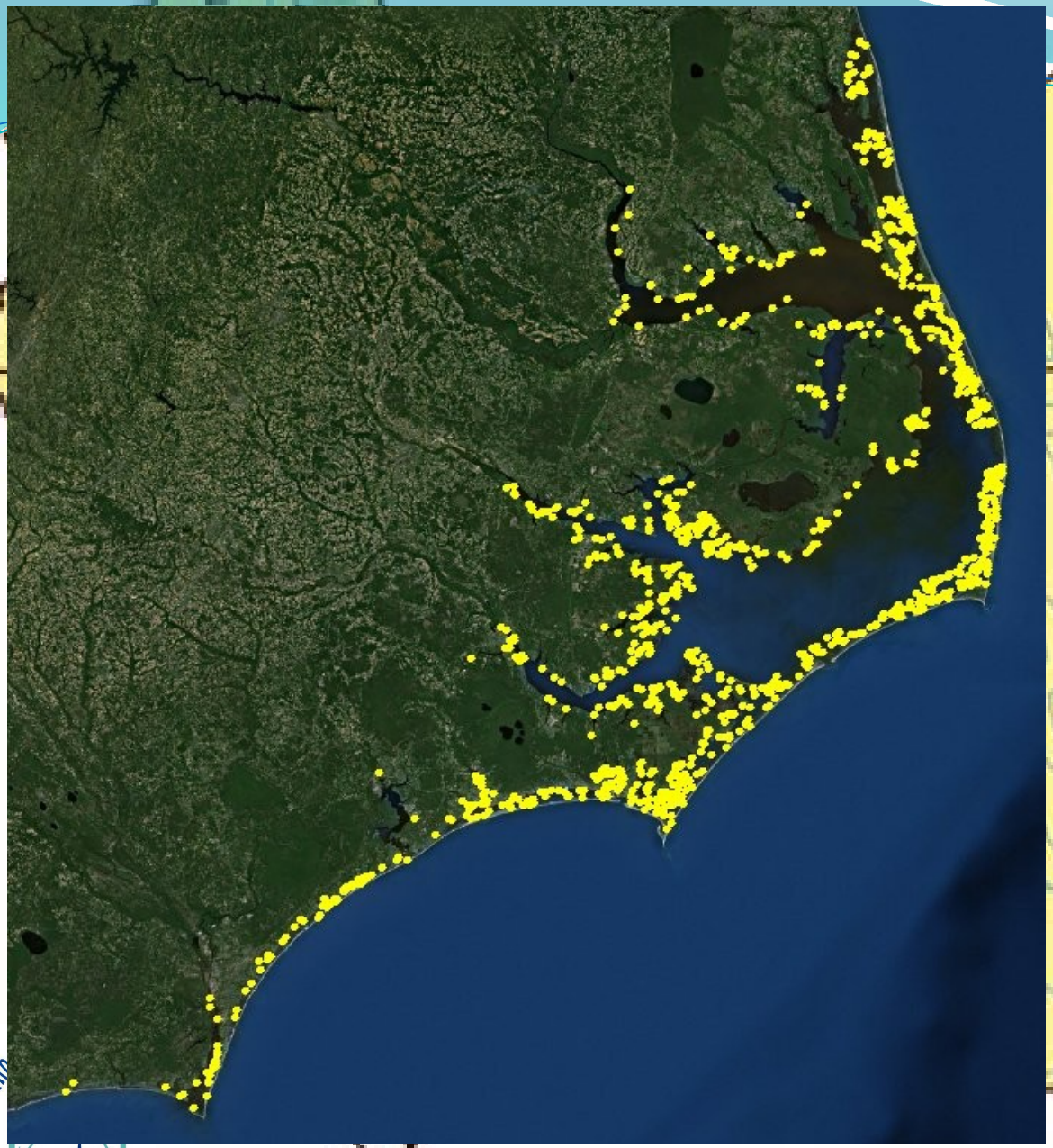
- Image acquisition: Intergraph's Z/I Digital Mapping Camera (DMC)
  - 24K feet above mean terrain
  - 1 m pixel resolution – 4 bands – Blue, Green Red and Near IR
- Photogrammetric control coordination: airborne GPS + ground-based GPS receivers
- Softcopy aero-triangulation
- Digital imagery orthorectification using DEMs



Field Verification Parameters: Autumn 2007

- Position
- Water Clarity
- Temperature
- Salinity
- Depth
- Species Identification
- SAV Density

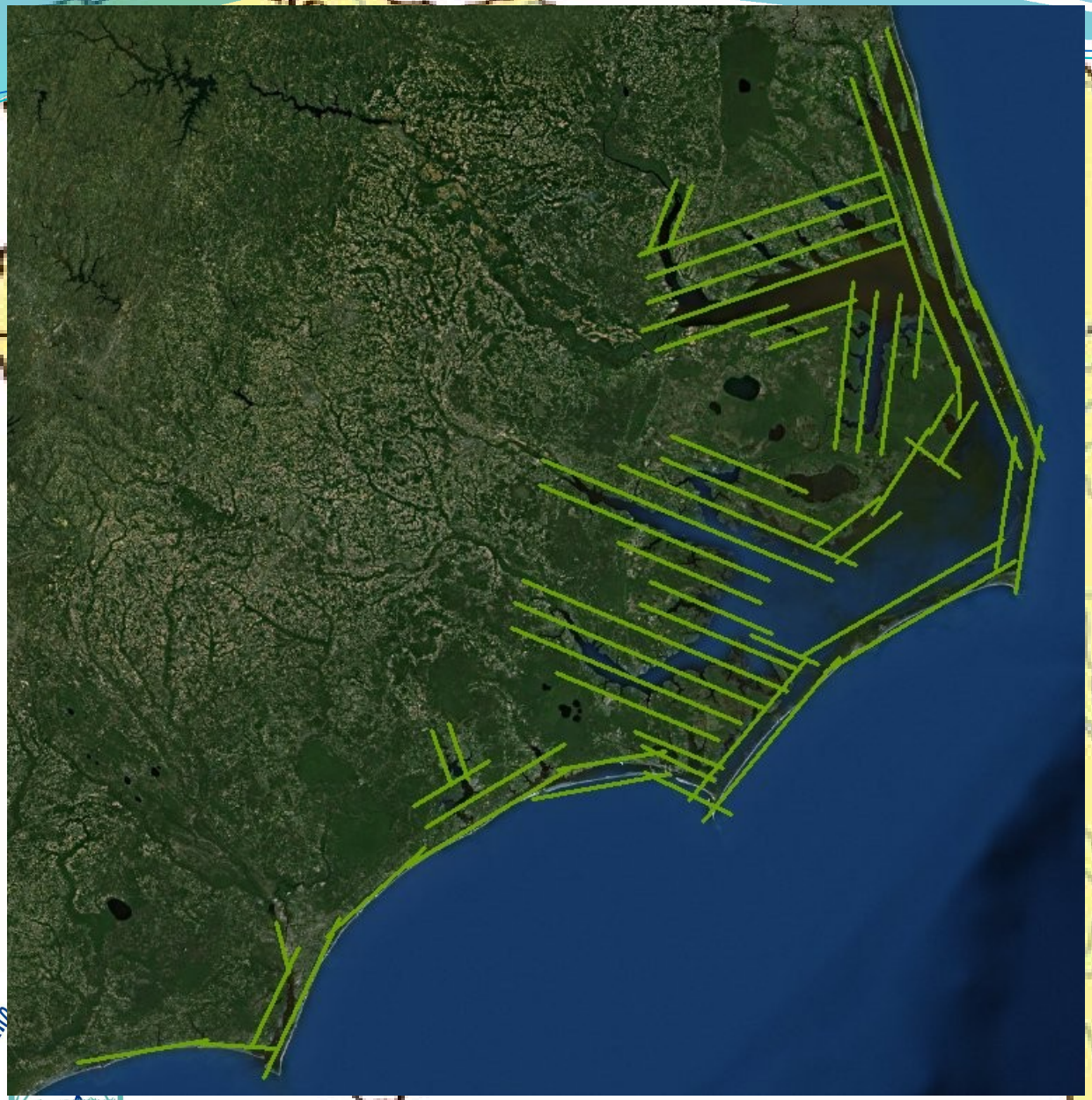




2007 Field Verification Points

- 1056 random points visited (82% by DMF)
- Points selected from areas where SAV was previously mapped or areas not previously mapped down to depth of 2m
- Points visited with small boats, SAV visualized from boats when possible, wading when possible and rakes when water too

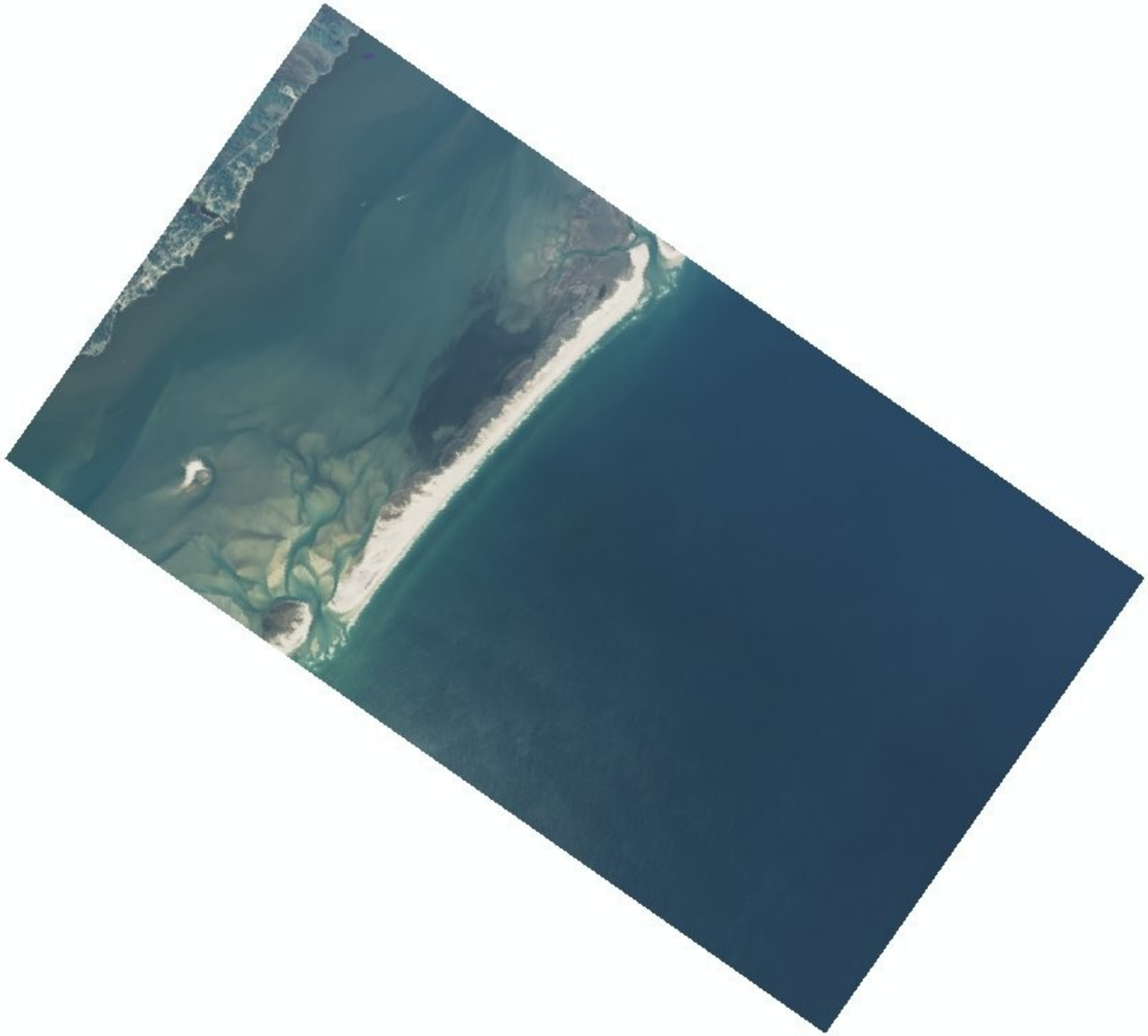
Intergraph's Z/I Digital Mapping Camera (DMC

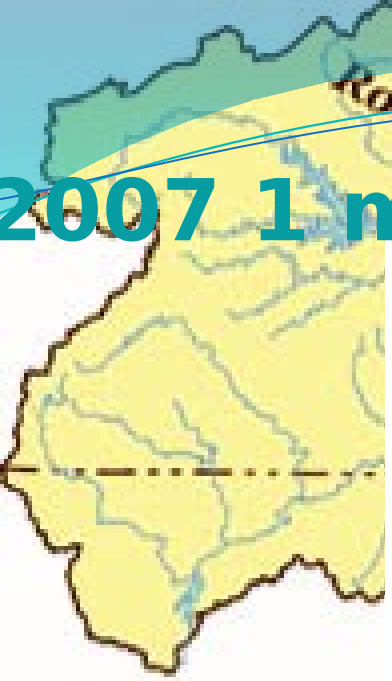


Autumn 2007 Spring 2008 Acquisition

- 1,795.45 flight line miles
- 1,347 images
- Bogue, Back, and the mainland side of Core Sounds from 2006 – 0.3 m pixel size flown at 10,000 ft.

2007 1 m DMC imagery – Drum Inlet, NC





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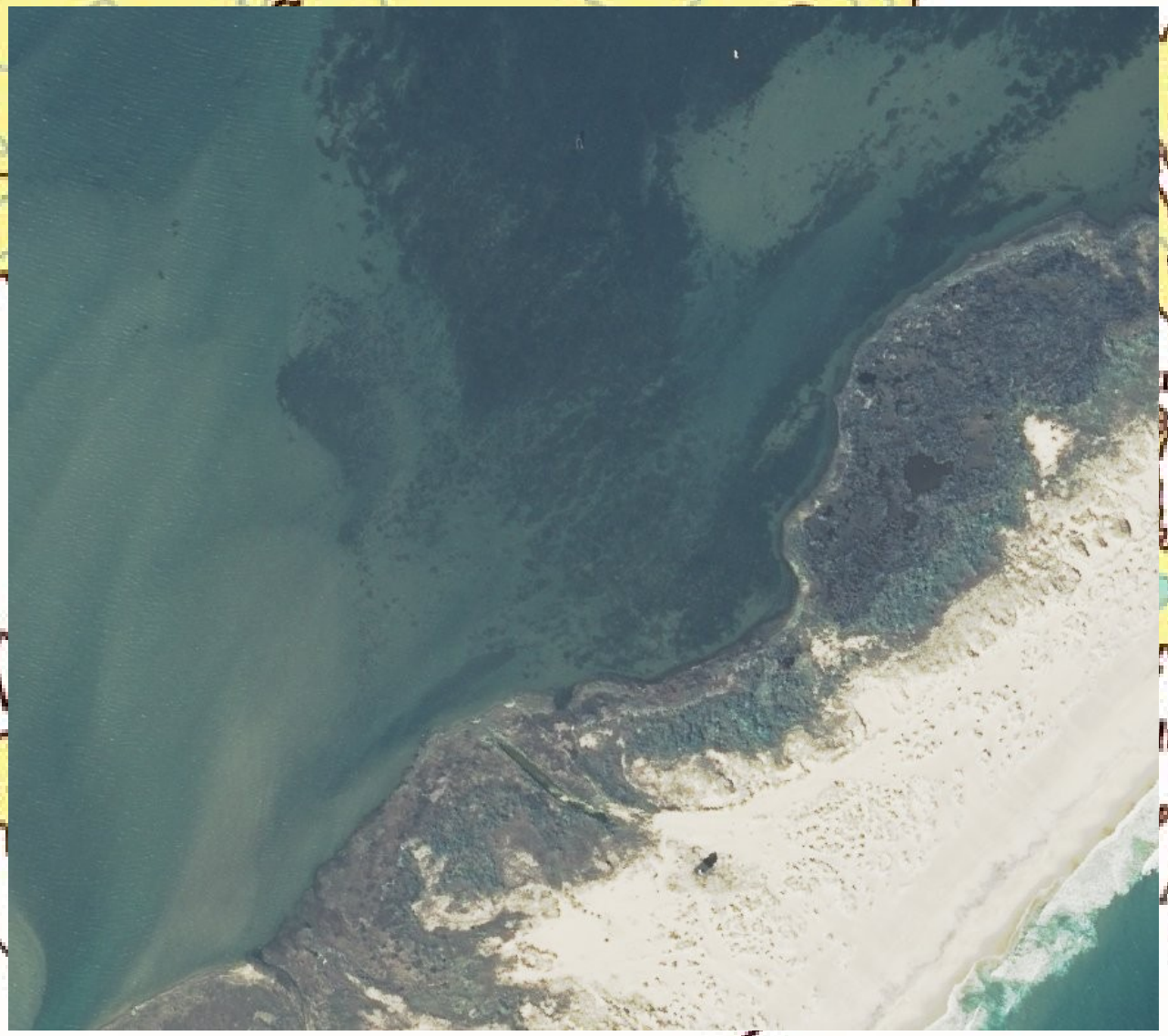
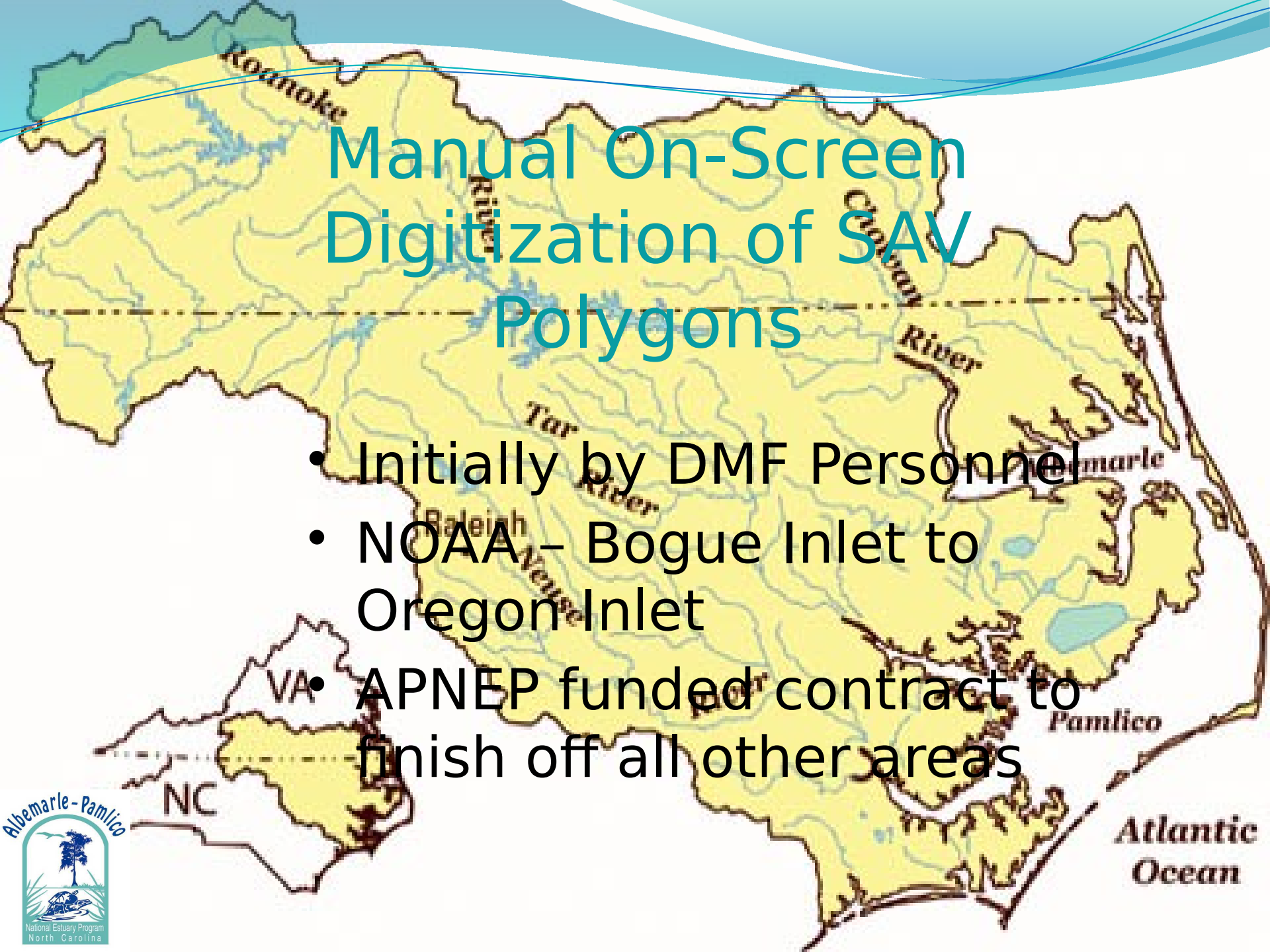
007 1 m DMC imagery – Drum Inlet,

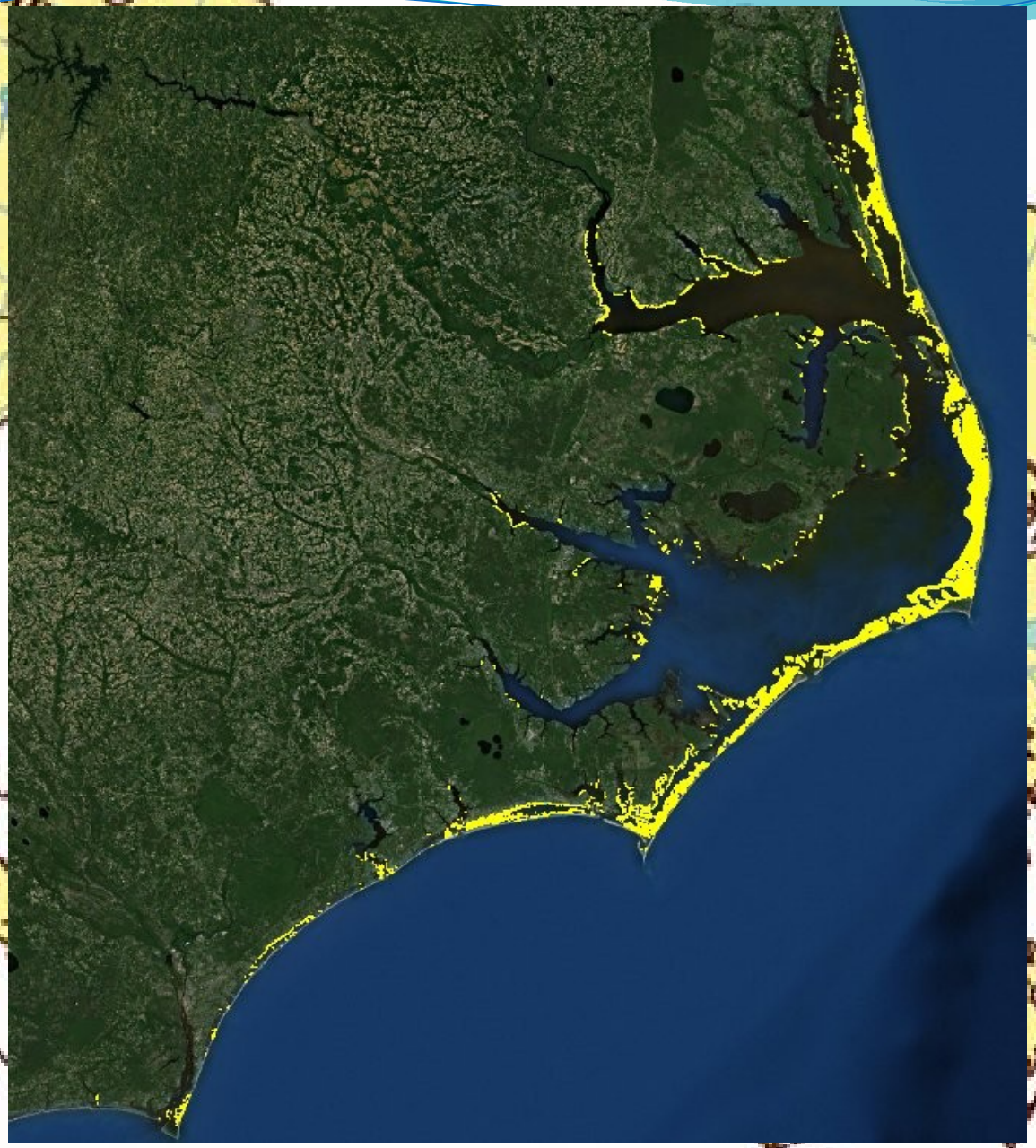


Manual On-Screen Digitization of SAV Polygons

- Initially by DMF Personnel
- NOAA – Bogue Inlet to Oregon Inlet
- APNEP funded contract to finish off all other areas



SAV in NC and Back Bay, VA 2006-2008



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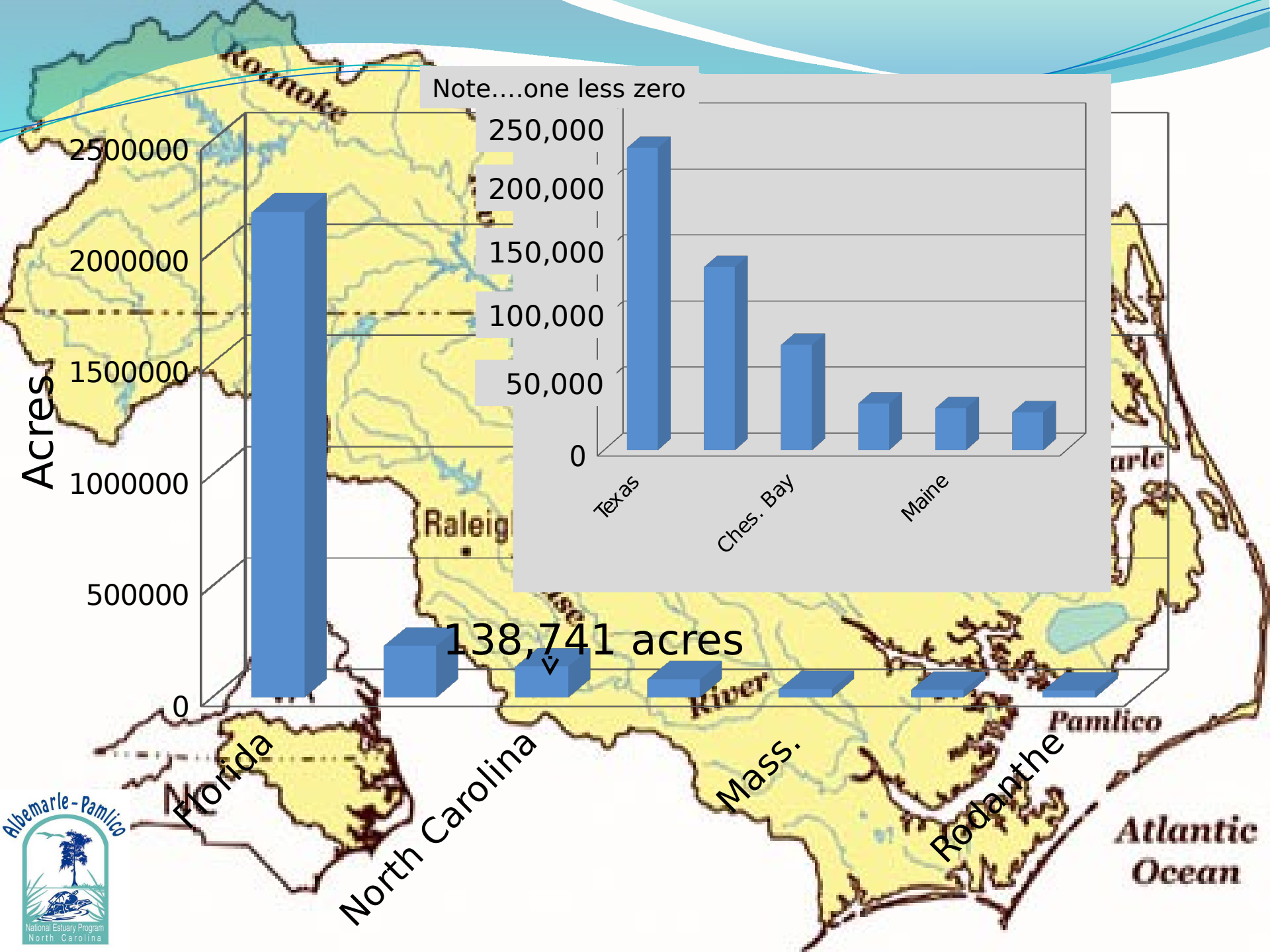
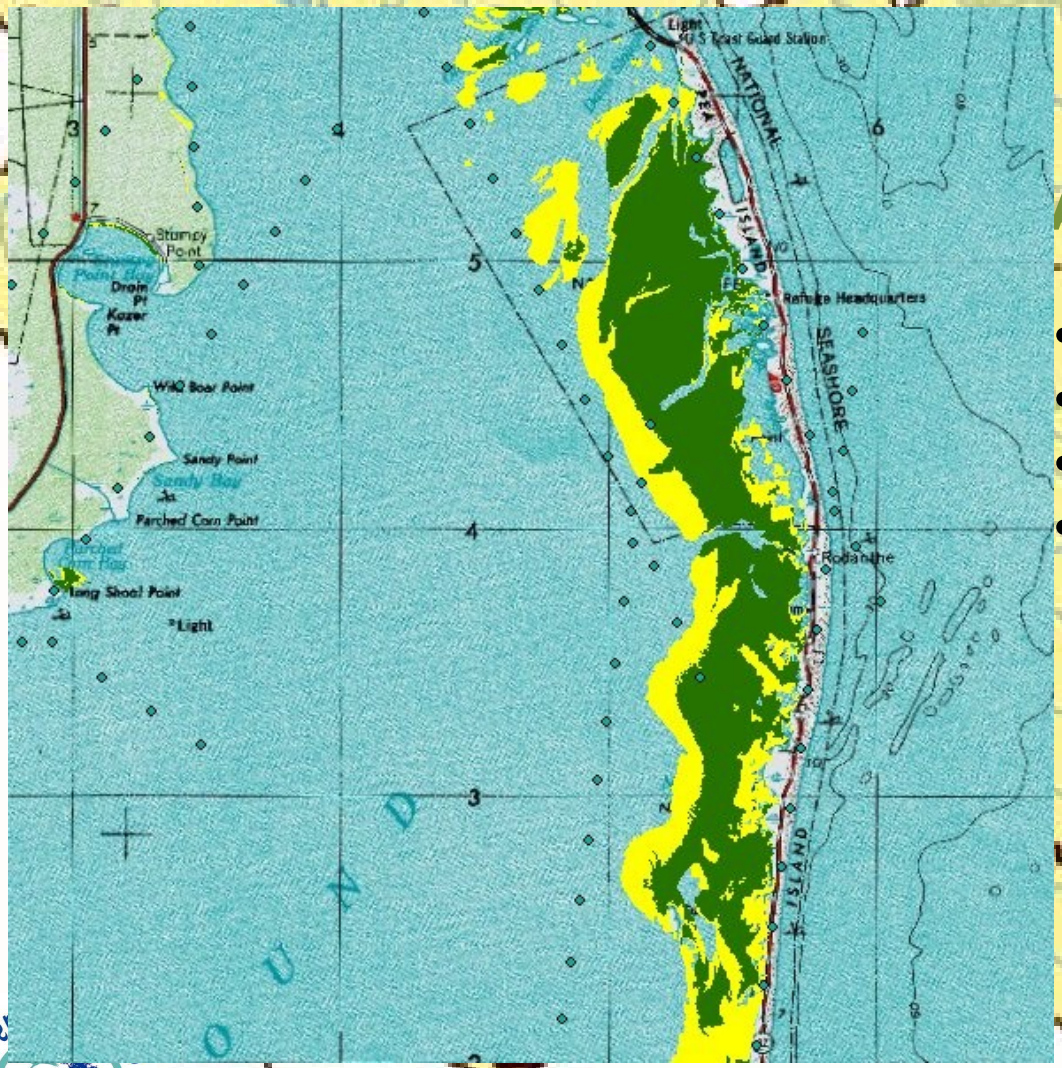

Note….one less zero
250,000
200,000
150,000
100,000
50,000
0
Texas
Ches. Bay
Maine
2500000
2000000
1500000
1000000
500000
0
Acres
138,741 acres
Florida
North Carolina
Mass.
Rodanthe
Pamlico
Atlantic Ocean
Albemarle-Pamlico
National Estuary Program
North Carolina

Oregon Inlet to Cape Lookout

- 86,103 acres
- 71% of State Total



Area South of Oregon Inlet

- **Length – 20 miles**
- **Width – 4 miles**
- **Total Area – 28,642 acres**
- **7th most SAV “State”**

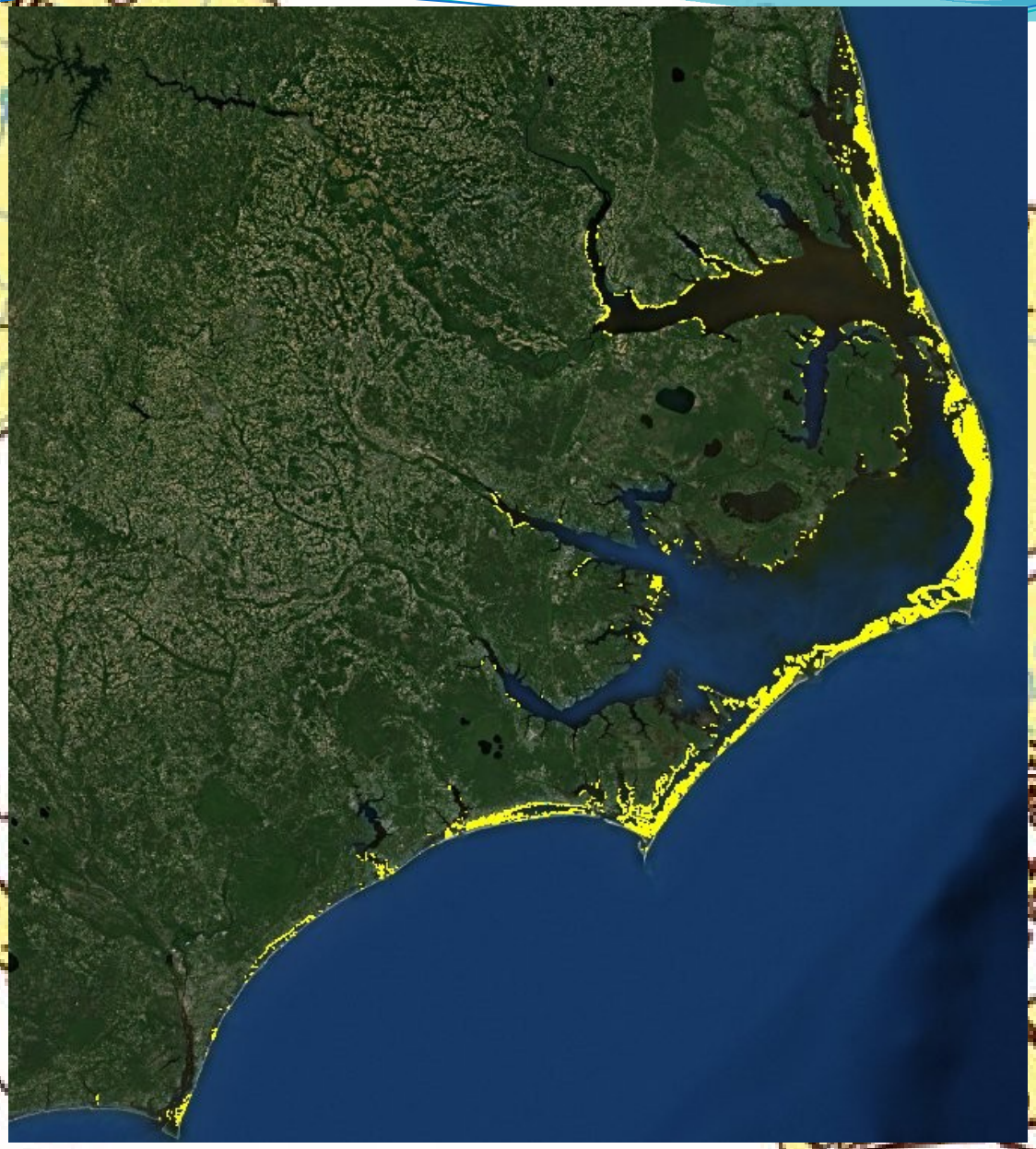
Roanoke
Albemarle
Pamlico
Atlantic Ocean

National Estuary Program
North Carolina

2007 1.0m DMC – Core Sound, North of Atlantic

Albemarle-Pamlico
National Estuary Program
North Carolina

SAV in NC and Back Bay, VA 2006-2008



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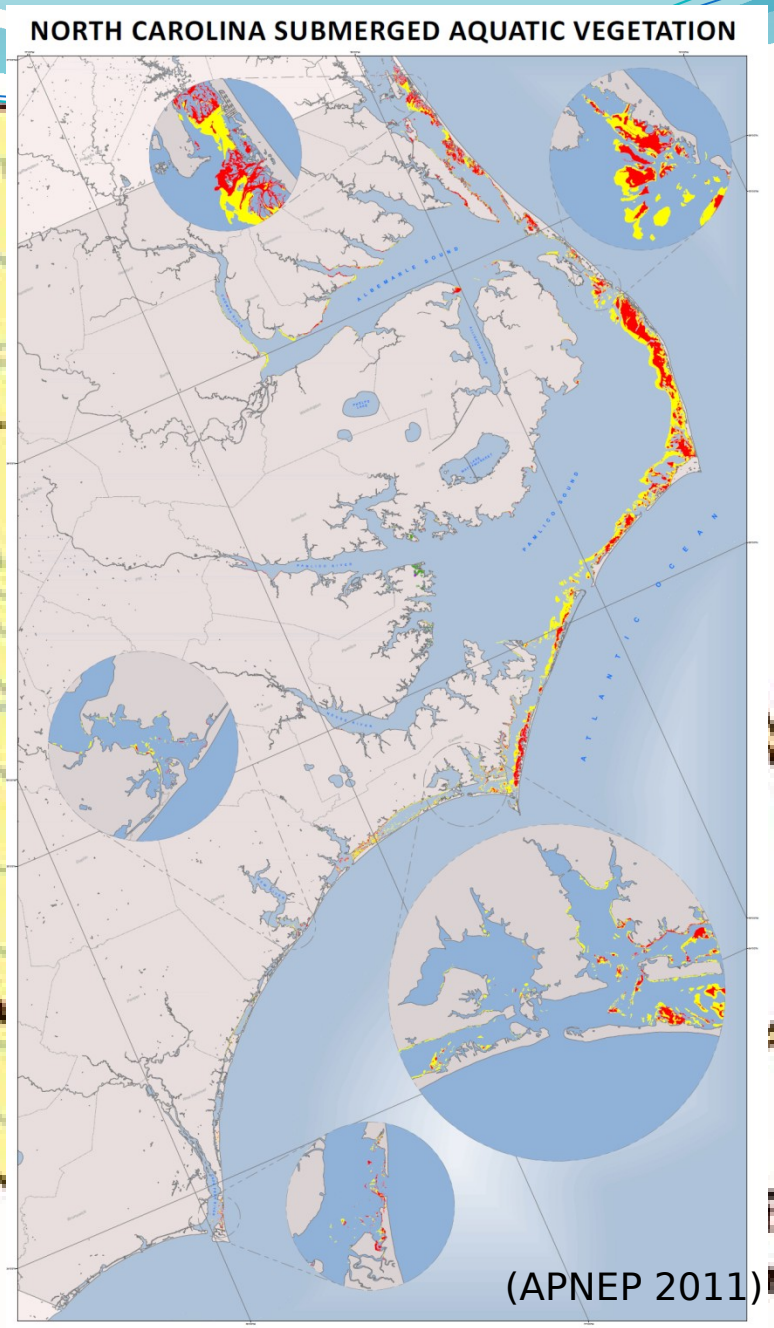
http://portal.ncdenr.org/web/apnep/resources/ma

Where Do We Go From Here?

- Already at the five-year period from the initial acquisitions
- Monitoring – NOAA, ECU, NCSU, APNEP obtained a CRFL grant to try to develop a statewide monitoring program
- Challenges
  - Aerial surveys only in coastal regions
    - Inland regions must be surveyed on-the-ground ("Invisible grass")
  - SAV is highly seasonal
    - N. limit of *Halodule wrightii*



Developing Protocols in high-turbidity submerged aquatic vegetation (SAV) beds in North Carolina's estuaries using single-beam sonar and low-light video

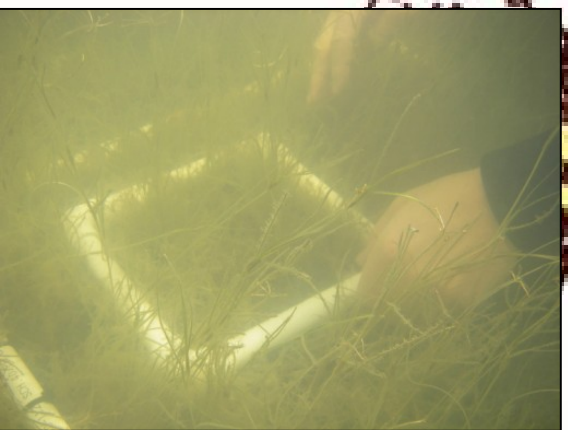
Cecilia S. Krahforst[1], Joseph J. Luczkovich[1], Christine Buckel[2], Don Field[2], Richard W. Curran[1], Dean E. Carpenter[3], Gayle R. Plaia[4], W. Judson Kenworthy[2]

[1] East Carolina University

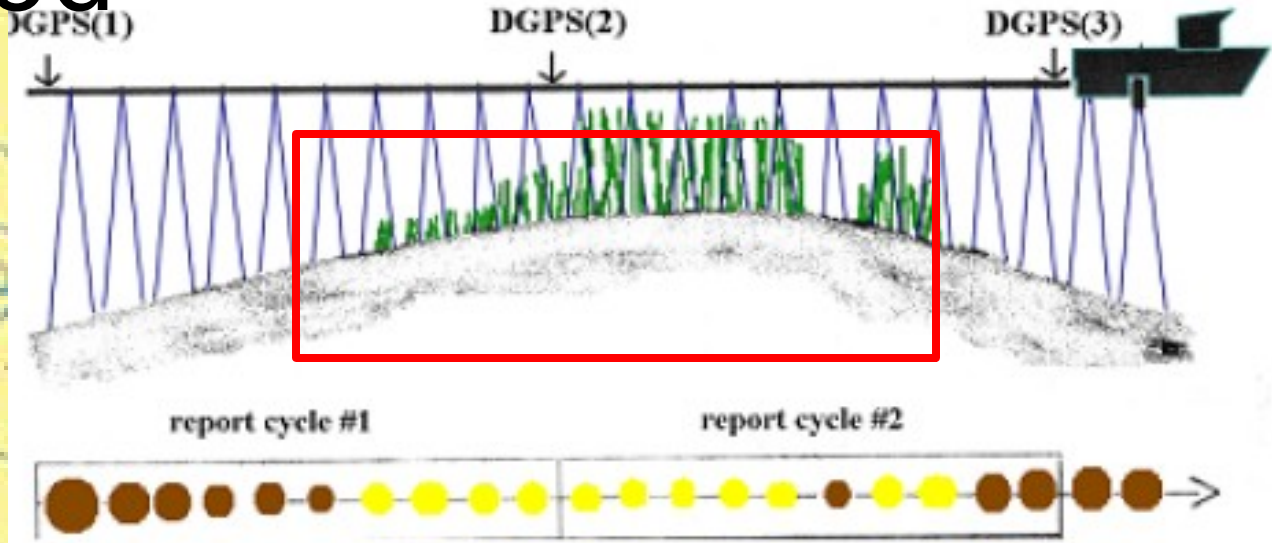
[2] National Oceanic and Atmospheric Administration

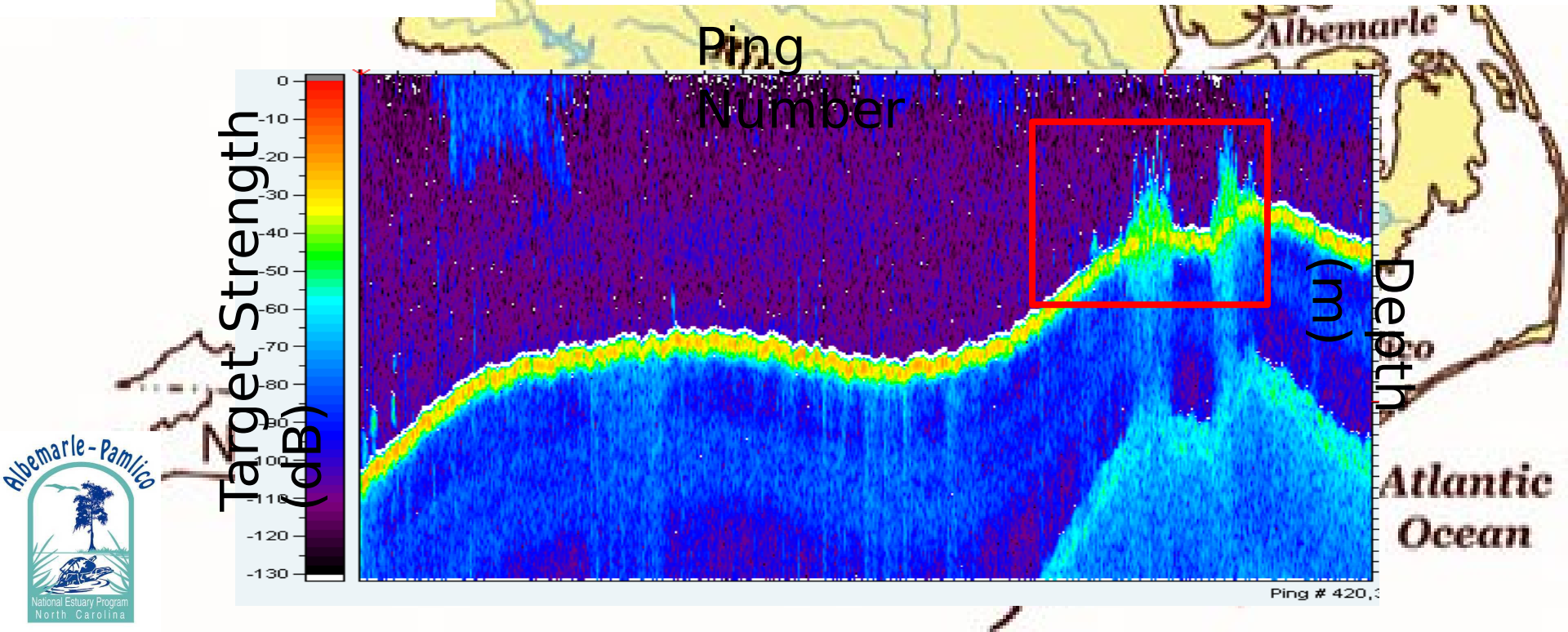
[3] Albemarle-Pamlico National Estuary Program

[4] North Carolina State University



SONAR Method





Video Method

- High resolution low light camera
- Differential GPS
- Continuous stamped video – date, time & location
- Camera fixed 13cm above bottom
- Frame size ~0.25m^2
- Individual frames classified for SAV presence/absence

2012 APNEP Ecosystem Assessment

Coasts, Sounds, Near Marine: Extent & Pattern

- Extent of Submerged Aquatic Vegetation
  - Why Is the Extent of the Submerged Aquatic Vegetation Important?
  - What DoesThis Indicator Report?
  - What Do the Data Show?
  - Why Can't This Entire Indicator Be Reported at This Time?
  - Understanding the Data
  - Technical Notes

Manage SAV Adaptively

- Most difficult step?
- Senior management engagement
- Trigger levels in plan

Acknowledgements

Don Field

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Dave Eggleston

Anne Deaton